EVALUATION OF SURVIVOR-06 WATER PURIFICATION DEVICE

K.W. JAMES, G.F. THOMSON AND A.T. HANCOCK

MRL-TN-625

MARCH 1993

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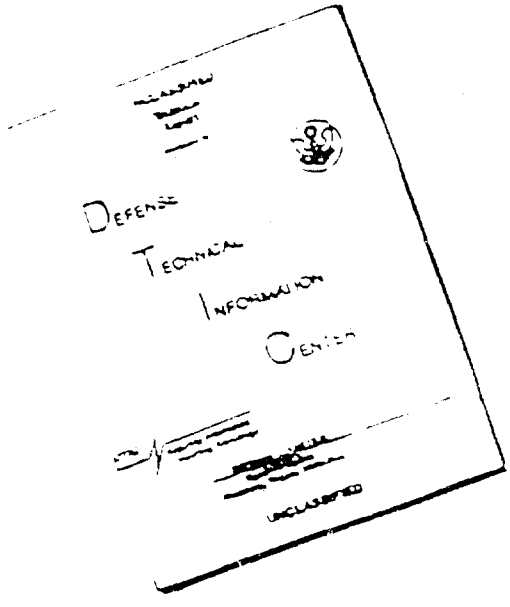

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REPORT DOCUMENTATION PAGE

1 AGENCY USE ONLY	2 REPORT DATE MARCH 1993	3 TYPE/DATES COVERED
4 TITLE AND SUBTITLE EVALUATIONN OF SURVIVOR-06 WATER PURIFICATION DEVICE.		5 FUNDING NUMBERS
6 AUTHOR K W JAMES, G F THOMSON AND A T HANCOCK		
7 PERFORMING ORG NAMES/ADDRESSES DEFENCE SCIENCE AND TECHNOLOGY ORGANISATION, MATERIALS RESEARCH LABORATORY, P.O. BOX 50, ASCOT VALE, VICTORIA 3032, AUSTRALIA.		8 PERFORMING ORG. REPORT NO
09 SPONSORING/MONITORING AGENCY NAMES AND ADDRESSES		
11 SUPPLEMENTARY NOTES		
12 DISTRIBUTION/AVAILABILITY STATEMENT UNCLASSIFIED Unlimited A		12B DISTRIBUTION CODE

13 ABSTRACT(MAX 200 WORDS) THE SURVIVOR 06 WATER PURIFICATION DEVICE WAS EVALUATED FOR THE EFFICANCY OF THE BIOCIDE CLEANING PROTOCOL AND THE EFFICIENCY OF THE DEVICE IN AUSTRALIAN DEFENCE APPLICATIONS. A FIELD METHOD OF ASSURING THE INTEGRITY OF THE MEMBRANE WAS DEVELOPED. IT WAS CONCLUDED THAT THE BIOCIDE CLEANING PROTOCOL IS EFFECTIVE, THE DEVICE IS SUITABLE FOR SUPPLYING EMERGENCY DRINKING WATER FOR RELATIVELY INACTIVE GROUPS OF UP TO THREE PERSONS, AND THAT THE INTEGRITY OF THE MEMBRANE SHOULD BE TESTED DURING ROUTINE MAINTENANCE USING A PROTOCOL BASED ON THE SEAMARK SEA MARKER DYE.

14 SUBJECT TERMS			15 NUMBER OF PAGES 11 16 PRICE CODE
17 SECURITY CLASS REPORT UNCLASSIFIED	18 SEC CLASS PAGE	19 SEC CLASS ABST.	20 LIMITATION OF ABSTRACT UL

Evaluation of Survivor-06 Water Purification Device

K.W. James, G.F. Thomson and A.T. Hancock

MRL Technical Note
MRL-TN-625

Abstract

The Survivor 06 water purification device was evaluated for the efficacy of the biocide cleaning protocol and the efficiency of the device in Australian Defence applications. A field method of assuring the integrity of the membrane was developed. It was concluded that the biocide cleaning protocol is effective, the device is suitable for supplying emergency drinking water for relatively inactive groups of up to three persons, and that the integrity of the membrane should be tested during routine maintenance using a protocol based on the SeaMark sea marker dye.

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AR No. 008-227

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1. Introduction

The Royal Australian Air Force Institute of Aviation Medicine (AVMED) requested an evaluation of a small, hand-operated reverse osmosis unit with the brand name *SURVIVOR-06* (Boothby, 1991). Two of the units were supplied, one packaged in original packaging. Literature detailing previous evaluations available to AVMED was provided.

The *Survivor 06* reverse osmosis water purification device is based on reverse osmosis membrane technology with a specially designed plumbing system to recover energy and minimise effort by the operator (Hembree, 1988). Operation and care of the device are fully described in the technical manual (Recovery Engineering, 1989) and a condensed version is supplied with the device (Lifestream, 1989).

The intended use of the device would be to supply water for drinking in an emergency. The device would be included as part of the survival equipment of the life raft used in small aircraft with only a few crew or passengers. Life rafts of large aircraft would be supplied with a larger device. It may also have applications for small Army units operating in inland Australia wishing to use highly saline bore water, or highly contaminated river or swamp water.

There is extensive literature documenting the efficacy of reverse osmosis for sterilising and desalinating water (Scott, 1981; Wellon and Soucey, 1987; Wellon, Kournikakis, Fulton, Bhatti, Fildes, Knodel and Spence, 1987; Aircraft Support Executive, 1989; Hembree, 1988; Dickinson, Burrows and Nelson, 1988). Provided the membrane is intact and the effluent tube has not become contaminated, then this technology is capable of providing potable water from sea water or swamp water. The manufacturer describes the membrane as a thin film polyamide composite (Recovery Engineering, undated), which has good resistance to hydrolysis and may be stored dry (Scott, 1981, p. 68). Thii membrane material is sensitive to chlorinated feed waters (Ko and Guy, 1988, p. 199), hence the membrane is sterilised with sulphite before drying and storage.

After reviewing the literature, it was decided that there were gaps in knowledge regarding the *Survivor 06* in the areas of:

1. efficacy of the biocide for cleaning the effluent tube for the likely period of usage in an emergency;

2. a field method of ensuring the integrity of the membrane during inspections of safety equipment;

3. efficiency of the device in Australian Defence survival applications.

2. *Methods*

2.1 *Chemical Methods*

Untreated waters were examined for pH and conductivity according to the *Standard Methods For The Examination of Water and Wastewater* (Franson, Greenberg, Trussell and Clesceri, 1985, p.431 and p.76).

A solution of sea marker dye was prepared and passed through the *Survivor 06* device. The spectrum of the dye solution and the permeate solution was scanned from 450 to 550 nm with a Shimadzu 240C Graficord UV-visible spectrophotometer.

2.2 *Microbiological Methods*

The efficacy of the biocide protocol provided by the manufacturer (Lifestream, 1989) was evaluated after treating naturally contaminated water from three sources that had various degrees of salinity. Total viable counts of micro-organisms were determined by the Pour Plate Method (SAA, 1975) for:

i. untreated water;
ii. permeate from passage of untreated water (i) through *Survivor 06* device;
iii. permeate, from passage of sterile deionised water through the *Survivor 06*, 24 h after biocide treatment.
iv. permeate, from passage of sterile deionised water through the *Survivor 06*, 5 d after biocide treatment.

3. *Results and Discussion*

Local natural waters were tested for use as feedstock for the *Survivor 06* with the results obtained in Table 1. Pond water was chosen as an example of biologically contaminated water with a low dissolved ion content. Great Forester River estuary water was chosen as a moderately brackish water with biological

contamination. The beach effluent water was chosen as a salty water with biological contamination.

Table 1: pH, Conductivity and Total Viable Count of Initial Untreated Water

Water Source	pH	Conductivity µS	Total Viable Count/mL
Pond water	8.9	1.2×10^3	6.2×10^3
Great Forester River estuary	8.1	1.4×10^5	4.0×10^3
Beach effluent (town drainage)	7.4	5.0×10^5	3.2×10^4

Treatment of further samples with the device virtually eliminated the biological contamination from each of the permeate waters (Table 2). The biocide protocol for the device was found to be effective over a five day period (Table 2). The two units tested gave similar results. Therefore, the device is effective, provided the membrane remains intact.

Table 2: Microbiological Results of Test Waters

Source Water	Treatment	Total Viable Count/mL
Pond water	Untreated	5.7×10^2
	Permeate	< 1
Sterile deionised water	24 h post biocide permeate	< 1
Great Forester River estuary	Untreated	3.8×10^4
	Permeate	< 10
Sterile deionised water	24 h post biocide permeate	< 1
Sterile deionised water	5 d post biocide permeate	< 1
Beach effluent (Town Drainage)	Untreated	2.5×10^5
	Permeate	< 1
Sterile deionised water	24 h post biocide permeate	< 1
Sterile deionised water	5 d post biocide permeate	< 1

The dye marker solution (strongly coloured red/green) was found to have an absorbance maxima of 2 absorbance units at 490 nm. The clear permeate from the dye marker solution was found to have zero absorbance at 490 nm. This demonstrates that the dye marker will not permeate through an intact membrane and can be used for field testing of the integrity of the membrane. A suggested field testing protocol is included at Appendix A.

Throughput of the permeate is of the order of 1 L/h (2 US pints/h, Hembree, 1988) using 2.8 kJ energy (Pers. comm., D. Watson, AVMED, 1991). The typical adult (70 kg male) requires a minimum of 2 L water per day and up to 20 L per

day under extreme conditions of climate and exercise. This throughput would be adequate for a group of up to three persons in a life raft when water production is the major exercise activity. It would be too slow and inadequate for an active small Army unit in inland Australia. There may be some applications when this device would be adequate for small Army units, but they would require conditions where the device could be used for a sufficient period.

4. Conclusions

The *Survivor 06* hand operated reverse osmosis water purification device is effective in producing potable water for an individual and groups of up to three persons, depending on the conditions of use. It is suitable for use in an emergency to supply water for crashed aircrew at sea. It may have limited applications for Army to desalinate bore water for small groups. However, a larger unit would be more effective.

The biocide treatment used for storage of the device is effective in preventing biological contamination of the permeate stream, provided the manufacturer's instructions are followed.

If the membrane is damaged, the permeate water will be brackish from a salty water source and the device will be easier to operate. It will also pass sea marker dye through the membrane. The sea marker dye should be used for routine testing of the device during normal maintenance as described in Appendix A.

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Appendix A

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Test for Membrane Integrity of Reverse Osmosis Water Purification Device

1. Add one small pellet (0.3 g) of sea marker dye (SeaMark) to 1 L water.

2. Allow at least 10 minutes with stirring for dye to disperse. The water becomes reddish green.

3. Pump through the *Survivor 06* sufficient dye solution to collect 50 - 100 mL of clear permeate solution.

4. If there is any evidence of green colour in the permeate water the membrane of the *Survivor 06* should be replaced.

5. Reverse osmosis water treatment devices that pass this test should be repacked using the biocide according to the manufacturer's instructions.

REPORT NO.	AR NO.	REPORT SECURITY CLASSIFICATION
MRL-TN-625	AR-008-227	Unclassified

TITLE

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REPORT DATE	TASK NO.	SPONSOR
March, 1993	90/073	DGFD(L)

FILE NO.	REFERENCES	PAGES
G6/4/8-4218	13	11

CLASSIFICATION/LIMITATION REVIEW DATE

CLASSIFICATION/RELEASE AUTHORITY
Chief, Protective Chemistry Division

SECONDARY DISTRIBUTION

Approved for public release

ANNOUNCEMENT

Announcement of this report is unlimited

KEYWORDS

Reverse Osmosis	Biocide Protocols	Potable Water
Microbiology	Membrane Integrity	Drinking Water

ABSTRACT

The Survivor 06 water purification device was evaluated for the efficacy of the biocide cleaning protocol and the efficiency of the device in Australian Defence applications. A field method of assuring the integrity of the membrane was developed. It was concluded that the biocide cleaning protocol is effective, the device is suitable for supplying emergency drinking water for relatively inactive groups of up to three persons, and that the integrity of the membrane should be tested during routine maintenance using a protocol based on the SeaMark sea marker dye.

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